CHAPTER 4

SURF OBSERVATIONS

INTRODUCTION

Amphibious warfare is the most complex operation in modern warfare. The safety and success of amphibious landings are largely dependent upon known surf conditions, although several other environmental factors can also have a profound effect. Surf conditions are reported by various individuals, depending upon the specific operation. Their input into surf forecasts (SURFCSTS) are key to major decisions. In this chapter, we will begin by discussing the causes of surf and surf zone characteristics in general. We will then focus on the actual surf observation (SUROB) at a beach, and describe the calculation of the modified surf index (MSI). Finally, we will discuss in detail how tides affect amphibious operations.

SURF ZONE CHARACTERISTICS

LEARNING OBJECTIVES: Identify the manual that provides information on surf zone terminology and detailed instruction on surf observation procedures. Identify the causes of surf. Recognize the effects of hydrography on surf conditions. Define the terms used in surf observations. Recognize the effects of refraction on waves.

On occasion, both Navy and Marine Corps weather observers may be called upon to support amphibious operations either in exercise conditions or in an actual beach assault. When the beach area is secure (in friendly hands), you may be tasked with observing and reporting surf conditions from the beach. Under hostile conditions, Navy UDT/SEALs or Marine Corps RECON personnel are normally tasked to conduct an on-scene, covert beach survey, which includes observing and reporting surf conditions. Aerial reconnaissance photography and satellite imagery can also provide a good indication of surf conditions at a hostile beach-landing area. Analysis of surf conditions from imagery is done by Navy and Marine Corps analysts/forecasters and Navy oceanographers working with photographic analysts.

COMNAVSURFLANT/PAClNST 3840.1, *Joint Surf Manual,* contains comprehensive information on amphibious operations, including surf observation procedures and a listing of various tables used for surf index calculations. All Navy and Marine Corps surf observers should review the *Joint Surf Manual.*

CAUSES OF SURF

Surf, the way that waves break near a beach, is caused by either local onshore winds or by swell waves traveling from a distant fetch area. The term *surf zone* describes the area between the shoreline and the outermost limit of the breakers. The surf zone encompasses the region between the first approaching breakers and the limit of wave uprush.

Surf created by local winds is characterized by breakers with irregular crests, short wave periods, and many whitecaps in the surf zone. Breakers produced by sea waves do not appreciably increase in height before they break. Surf created by swell waves produces breakers with a more rounded appearance and with a more regular, but longer period. Swell waves offshore appear low and rounded, but just before breaking they rapidly increase in height and steepness. Although sea waves and swell waves usually exists simultaneously, it is the swell that most often presents a problem for amphibious operations.

Surf forms as deep-water waves approach shallow water. Deep-water waves are waves moving over water that has a depth greater than one-half the average wavelength. Deep-water waves approaching the beach will “feel bottom” when the depth of the water is approximately one-half the deep-water wavelength. When a wave feels bottom, *wave speed* and *wavelength* decrease while *wave height* increases. As this happens, the face of the wave becomes steeper. The *steepness* of a wave refers to the ratio of wave height to wavelength.

Waves become breakers when the wave spills water down the face of the wave (the wave crest). Once the steepness of a wave becomes 1/7 of the wavelength, the wave becomes unstable and begins to break. When approaching a beach, a wave will normally break when the water depth is 1.3 times the wave height, but may vary slightly depending on bottom topography. Thus, with 6-foot breakers, the breaker line is located where the depth to the bottom is about 8 feet.

SURF ZONE HYDROGRAPHY

Besides the winds and seas, the hydrography of a beach has a major impact on the character of surf. The hydrography in a surf zone includes the water depth, nearshore currents, tides, the shoreline configuration, the beach slope (gradient), and bottom composition. In fact, the beach slope is the most important factor in determining the type of breaker most likely to be present. Due to dissipation over distance, waves breaking closer to shore will do so with less energy and lower heights than waves breaking farther offshore. Bottom features, such as ridges, canyons, sandbars, and troughs, can greatly affect where waves break. It is important to remember that ridges and sandbars will cause waves to break farther from shore and with stronger force. When waves are observed that consistently break in the same area from one day to the next, there is probably a submerged feature such as a sandbar or reef in the surf zone.

Knowledge of beach hydrography is essential to producing accurate surf forecasts. There are many sources of hydrographic data, including climatological charts and tables, intelligence reports, seal team reconnaissance reports, as well as high resolution shallow water satellite imagery. Keep in mind that sandbars and other bottom features shift with the tides and seasons. Therefore, the *more* recent any beach survey information is, the more accurate and useful it will be.

DESCRIPTIVE TERMS RELATING TO SURF OBSERVATIONS

Many terms used to conduct a surf observation are unique to either the observation or to an amphibious assault. Every observer must know what these terms mean in order to conduct a proper surf observation, commonly called a SUROB. See figure 4-1. The following factors greatly influence surf:

- *Beach orientation* or *beach face*—the true direction a person standing on the beach and looking out to sea would face,

- *Beach slope*—the ratio of the drop in bottom depth compared to the horizontal distance traveled in the surf zone (rise over *run).* Usually obtained by seal team surveys or from hydrographic charts.

DESCRIPTIVE TERM	SLOPE (every 1 unit of rise per unit of beach length)
Steep	Greater than 1:15
Moderate	1:15 to 1:30
Gentle	1:30 to 1:60
Flat	Less than 1:120

- *Coastal zone topography*—the presence of islands or other wave-blocking, offshore land masses that affect wave refraction (bending of wave trains).

- *Near-shore and offshore bottom hydrography*—the presence of underwater sandbars, ravines, reefs, or other features on the ocean bottom. Coral and rocks can cause hazards to personnel and equipment.

- *Sandbars*—formed as a result of sand transported by waves and currents. Unlike reefs, these are transitory in nature and change with the seasons and tides. They may be exposed during low tide and cause landing craft to become stuck. In addition, the volume of water carried over the bar must return seaward. The return flow may

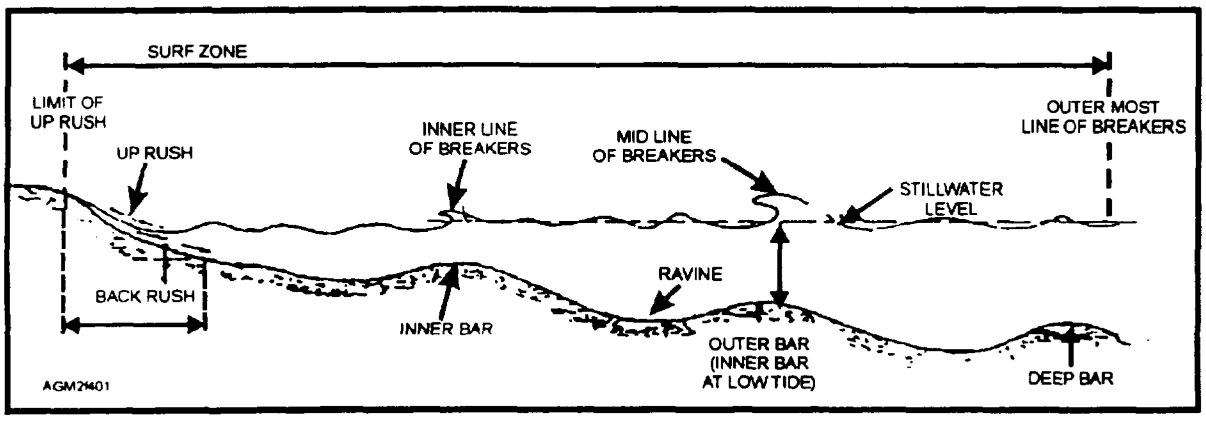

Figure 4-1.—Nearshore profile.

become focused and cut gaps or channels in the offshore bar. This return current is called a rip current. There may be several sandbars present in a surf zone.

The following factors normally will change in a short period of time(within 24 hours) and will affect the surf conditions you observe from the beach:

- Deep-water sea-wave height. direction, and period.
- Deep-water swell-wave height, direction. period, and the pattern of the waves within a swell-wave group.
- Presence of secondary wave systems that may create a more confused surf zone. These are discussed later in this chapter.
- Stage of the tides; that is, the height and pattern of the normal rise and fall in the water level.
- Set (direction) and drift (speed) of rising and falling tidal currents.
- Set and drift of semipermanent coastal water currents (usually obtained from hydrographic charts).
- Surf beat (the rise and fall of the entire water level within the surf zone). The surf beat is significant to landing craft approaching submerged obstacles, such as sandbars.
- Wind speed and direction.

Although all these factors must be evaluated when a forecast of surf conditions is calculated, you, as the observer. need to be aware of the factors that change with the weather and tides. Normally, your report of surf conditions. as affected by these changing factors, is evaluated by the forecaster. The forecaster then will interpret how forecasted deep-water waves will react when approaching the beach under various conditions.

WAVE REFRACTION

Refraction is the bending of waves toward areas of slower wave speed. As a wave travels over shallower water and begins to interact with the bottom, the wave speed decreases. If the wave is traveling at an angle to the beach. the portion of the wave in shallow water slows down while the portion of the wave in deep water continues at the same speed, causing the wave to become more parallel to the beach. Wave refraction may also occur due to irregularities of the coastline and bottom contours. Waves will bend toward points protruding from shore due to the shallower water surrounding them. This process concentrates much more wave energy onto the protrusions than the embayments between them, as illustrated in figure 4-2. To predict variation in surf along a coastline, forecsater personnel create refraction diagrams. Several different wave direction, height. and wave period scenarios may be used.

In the following text, we will discuss how to report observed surf conditions.

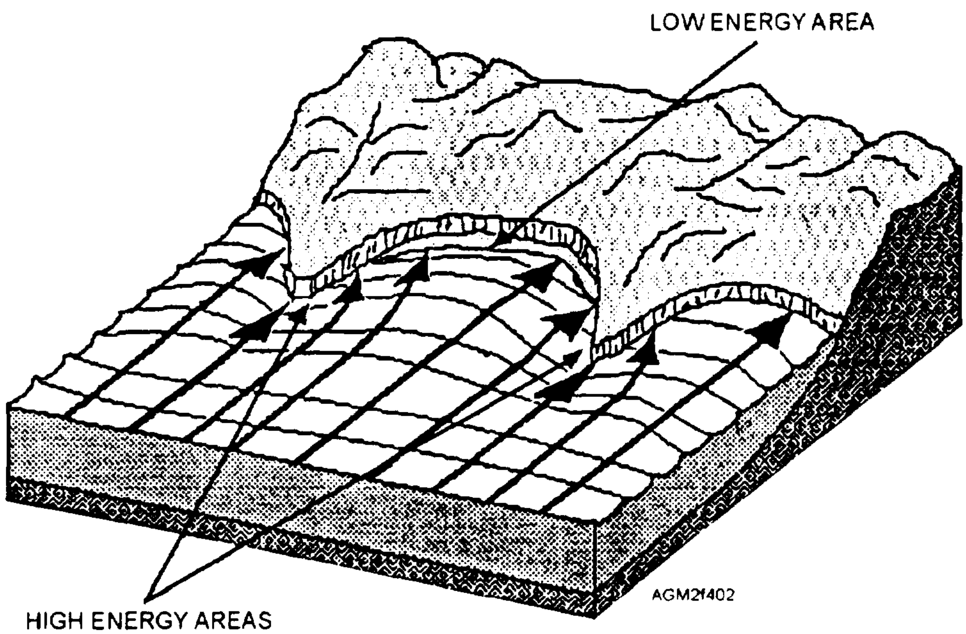

Figure 4-2.—Wave refraction due to coastal irregularities.

REVIEW QUESTIONS

Q1. *What publication outlines procedures for conducting surf observations?*

Q2. *What are two factors that can create surf?*

Q3. *What are the boundaries of the surf zone?*

Q4. *When a wave enters shallow water, what happens to the wave speed, wavelength, and wave height?*

Q5. *How is wave steepness defined?*

Q6. *The hydrography in a surf zone includes what elements?*

Q7. *How does the presence of a sandbar effect waves moving into a surf zone?*

Q8. *What descriptive term is used to classify a beach with a slope of 1:25?*

Q9. *What affect might a sandbar have on small craft operations?*

Q10. *What is meant by the term "wave refraction"?*

THE SURF OBSERVATION

LEARNING OBJECTIVES: Describe the procedures used to observe surf conditions. Describe how to record and transmit surf observations.

Surf observers report surf conditions by using a special code. Individual surf elements are reported by using standard designators, such as ALFA (to indicate significant breaker height), BRAVO (to indicate maximum breaker height), and so on. Surf forecasts (SURFCSTS) are issued in the same format and are just one part of the Amphibious Objective Area Forecast (AOAFCST) produced by forecaster personnel. SUROBs are recorded on a locally reproduced SUROB worksheet (fig. 4-3).

BEACH FAMILIARIZATION

During amphibious operations, beaches are identified by color codes. A 3-mile-long section of beach, for example, may be broken down into shorter sections identified as Red Beach, Purple Beach, or Green Beach. Normally, even on an irregular coastline, planners try to divide the larger beaches into sections with similar characteristics. The orientation of the beach and the beach slope should be fairly uniform for a beach called Green Beach, even though an adjacent beach area, perhaps called Red Beach, may have a dramatically different orientation and slope. In addition to color designations, beaches may also be identified by letter abbreviations alone. When tasked to provide SUROBs, you, the observer, must first familiarize yourself with the beach designations and boundaries involved, since separate observations may be required for each beach area.

SURF OBSERVATION ELEMENTS

The SUROB worksheet is completed (and saved) for each individual SUROB. The observation number, the date and time of the observation (in UTC), and the beach identification are entered on each form as the first part of each SUROB report.

Breaker Height (ALFA/BRAVO)

When observing the surf, you must observe the breaker heights of 100 individual breakers. Normally, breaker height is evaluated in an area where the waves are breaking nearest the beach. Breaker height is estimated to the nearest half-foot and is entered in the Wave Height Observation blocks on the SUROB worksheet. After observing 100 individual breakers, enter the *significant* breaker height, which is the average height of the highest one-third of all the observed breakers. Enter to the nearest 1/2 foot, as element ALFA on the SUROB report. Enter the maximum breaker height (the height of the single highest breaker observed) to the nearest 1/2 foot as element BRAVO.

Breaker heights are usually best estimated from a position close to the waterline on the beach. One fairly accurate method for estimating breaker height calls for the observer to line up the top of the breaker crest with the horizon. The height of the breaker is the vertical distance from this line to the seaward edge of the uprush zone. The *uprush zone* is the area on the beach where the waves cause the water to temporarily rush up on the sand, and then recede on the wave backwash to expose the sand. This method becomes less accurate as the distance from the observer to the breakers increases. See figure 4-4.

In cases where a longshore sandbar is present, the highest breakers may occur over the sandbar, with only smaller breakers occurring near the beach. This is the case at low tide. If you observe higher, more significant breakers offshore (over a submerged sandbar), enter

WAVE HEIGHT OBSERVATIONS
P=PLUNGING
S=SPLLING
X=SURGING
TIME BEGAN__ MIN__Sec

P S X	P S X	P S X	P S X	P S X

TIME ENDED ____MIN ____SEC

WAVE PERIOD COMPUTATION
ELAPSED TIME ___MIN ___SEC

TOTAL SECONDS=$\frac{\_\_\_\_}{100}$= ____= **CHARLIE**

NOTE: (ECHO-FOXTROT)
RIGHT OR LEFT FLANK AS SEEN FROM SEAWARD

SURF OBSERVATION REPORT
SUROB NO ____________________ BEACH

____
DAY-TIME OF OBSERVATION

ALFA ________**PT** ________
SIGNIFICANT BREAKER=AVERAGE OF HIGHEST ONE-THIRD TO NEAREST HALF FOOT

BRAVO ________**PT** ________
MAXIMUM BREAKER=NEAREST HALF FOOT

CHARLIE ________ **PT** ________
PERIOD=FIVE TENTHS; OF A SECOND

DELTA ____**PLUNGING** ____**SPILLING**
____**SURGING**
BREAKER TYPE=PERCENT APPLICABLE

ECHO ____**TOWARD** ____**FLANK**
RIGHT/LEFT (SEE NOTE)
BREAKER ANGLE=ACUTE ANGLE THAT BREAKER MAKES WITH BEACH

FOXTROT____**PT**____ **KT**____ **TOWARD** ___**FLANK**
RIGHT/LEFT (SEE NOTE)
LITTORAL CURRENT=MEASURED TO NEAREST TENTH OF A KNOT 1 KNOT=100 FT PER MINUTE

GOLF ___**TO**___ **LINE IN** ___**FT**
SURF ZONE SURF ZONE=PREDOMINANT NUMBER OF BREAKER IN AND WIDTH OF

HOTEL ____________________
____
____
PERTINENT REMAKRS=WIND-WEATHER-VISIBILITY SECONDARY WAVE SYSTEM, ETC

AGM21403

WAVE HIGHT COMPUTATION
FOR HIGHEST 33 WAVES
HEIGHT X OCCURRENCE=PRODUCT

______ X ______ = ______
______ X ______ = ______
______ X ______ = ______
______ X ______ = ______
______ X ______ = ______
______ X ______ = ______

TOTAL = $\frac{\_\_\_\_\_\_}{33}$= ______ = **ALFA**

Figure 4-3.—SUROB worksheet.

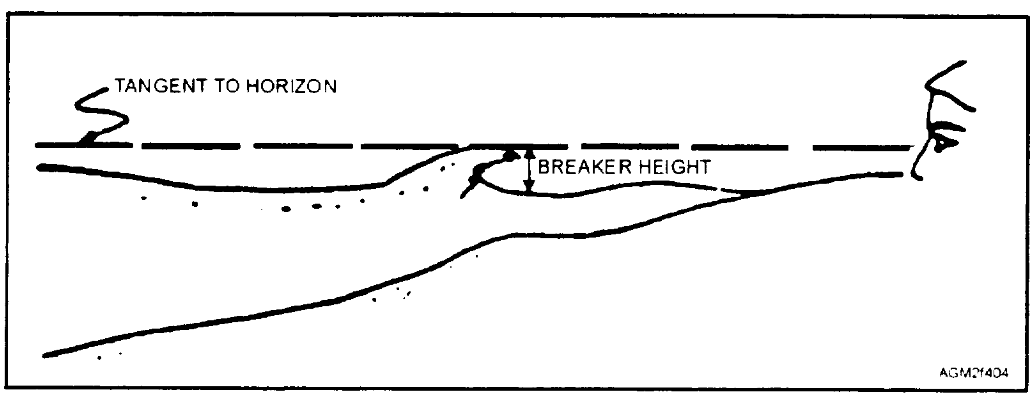

Figure 4-4.—Estimating breaker height from beach.

this information in the Remarks section, element HOTEL. An evaluation of the offshore breaker height and type should be included with the remarks. For example, HOTEL: HIGHER BREAKERS 50 YD OFFSHORE, ALFA 9 PT 0, BRAVO 12 PT 5, DELTA 80 PLUNG 20 SPILL. Elements CHARLIE, ECHO, FOXTROT, and GOLF need not be included in the remarks section.

Breaker Period (CHARLIE)

The total time (in seconds) for 100 successive waves to be observed, divided by 100, is the average breaker period. This value is entered to the nearest half-second as element CHARLIE of the report. The average breaker period is normally the same or very close to the deep-water wave period. Generally, breakers with shorter periods are much more difficult for landing craft to negotiate.

Breaker Type (DELTA)

Breakers are classified as spilling, plunging, or surging breakers, depending on their appearance (fig. 4-5). The steepness of the wave front, a function of the slope of the bottom, is the most critical factor as to what type of breaker will be formed. Bottom irregularities and local winds also influence breaker type. Keep in mind that breaker characteristics can vary considerably with respect to time and location.

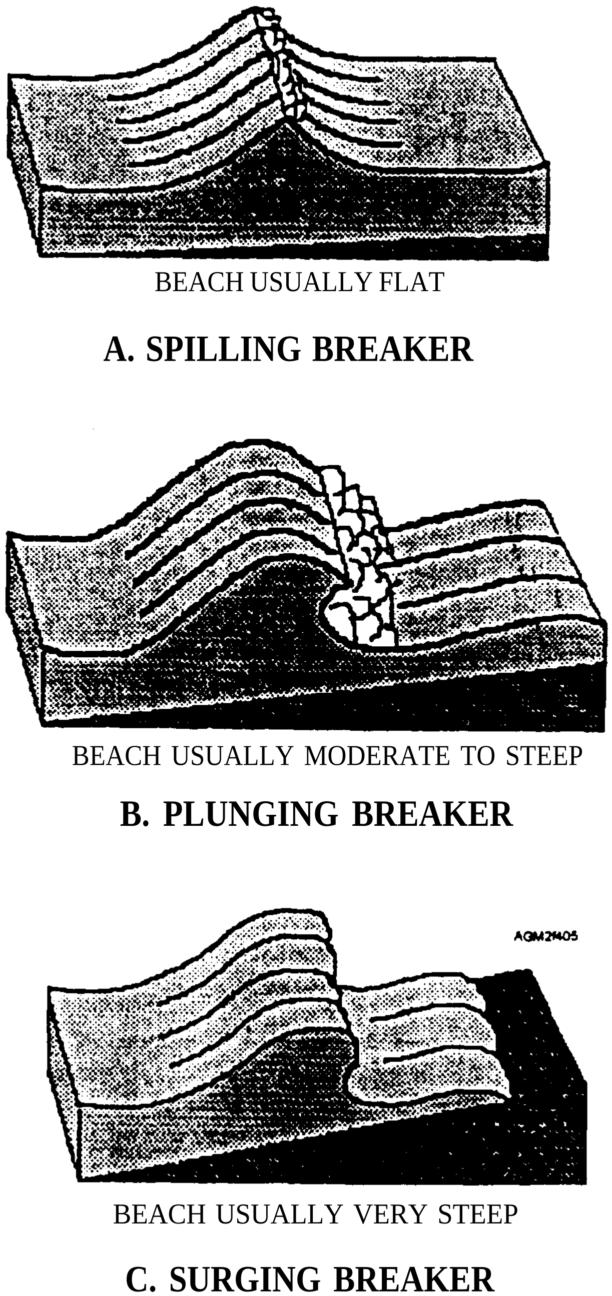

Figure 4-5.—General character of (A) spilling, (B) plunging, and (C) surging breakers.

Spilling breakers occur with gentle and flat beach slopes. As a wave moves toward the beach, steepness increases gradually and the peak of the crest gently slips down the face of the wave. The water at the crest of a wave may create foam as it spills over. Spilling breakers also occur more frequently when deep-water sea waves approach the beach. The shorter wavelength of a sea wave means that the wave is steeper in the deep water and that the water spills from the crest as the waves begin to feel bottom. Because the water constantly spills from the crest in shorter wavelength (shorter period) waves, the height of spilling waves rarely increases as dramatically when the wave feels bottom, as do the longer period waves. Because they occur on mild sloping beaches, spilling breakers typically produce surf zones that extend far offshore.

Plunging breakers occur with a moderate to steep beach slope. In this type of breaker, a large quantity of water at the crest of a wave curls out ahead of the wave crest, temporarily forming a tube of water on the wave face, before the water plunges down the face of the wave in a violent tumbling action. Plunging breakers are characterized by the loud explosive sound made when the air trapped in the curl is released. Plunging breakers are more commonly associated with swell waves, which approach the beach with much longer wavelengths. The shortening of the wavelength as the wave feels bottom causes a great mass of water to build up in the crest in a short time. Longer period swell waves may double in height when feeling bottom

Surging breakers are normally seen only with a very steep beach slope. This type of breaker is often described as creating the appearance that the water level at the beach is suddenly rising and falling. The entire face of the wave usually displays churning water and produces foam, but an actual curl never develops. The water depth decreases so rapidly that the waves do not reach critical steepness until they are right on the beach. The entire wave surges up the beach and most of the energy is reflected back seaward. These wave can be very dangerous for landing craft. After the wave pushes the craft up the beach, the entire wave returns as a wall of water striking the craft.

Your determination of breaker height and breaker type is a very important part of the SUROB. The breaker type should be entered along with each entry of breaker height on the SUROB worksheet. Breaker type is to be evaluated for the same 100 breakers evaluated for height. All the breakers in the significant breaker area need not be the same type of breaker. You may, for instance, see three plunging breakers followed by four spilling breakers. The SUROB report requires that the percentage of each type of breaker observed be entered as element DELTA.

Breaker Angle (ECHO)

Because wave speed decreases as the waves enter shallower water, waves approaching the beach at an angle are refracted and approach the beach more parallel. Although waves are refracted, many situations produce breakers that approach the beach at an angle. Breaker angle is the angle the breaker makes with the beach, and is a critical factor in the creation of a littoral current. The greater the breaker angle, the stronger the littoral current.

Breaker angle must also be identified by the direction toward which the breakers are moving. Beach directions are identified by the direction as seen from an approaching landing craft. Looking from the sea toward shore, the left flank is toward a landing craft's left side (port side) and the right flank is toward the landing craft's right side (starboard side). See figure 4-6. Breaker angle is entered as element ECHO of the

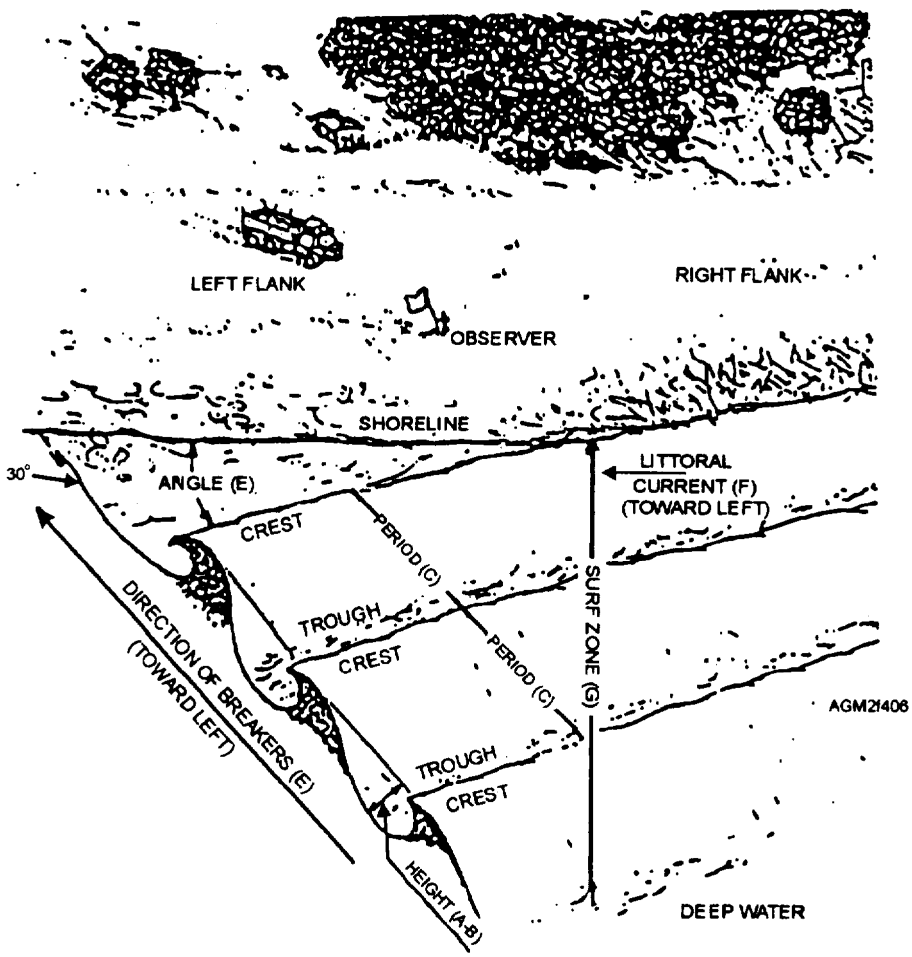

Figure 4-6.—Wave angle and beach directions. The wave angle in this case is about 30 degrees left flank.

SUROB. If several breaker angles exist and breaker lines are moving toward both flanks, the following entry is made: 10-20 toward R/L flank. If the breakers are directly parallel to the beach, the entry should be: 0 toward R/L flank.

REVIEW QUESTIONS

Q11. During amphibious operations, how are individual beach sections identified?

Q12. How is significant breaker height determined in a surf observation?

Q13. Plunging breakers are associated with what type of waves?

Q14. What type of breakers would you expect to find on a beach with a very steep slope?

Q15. How do you determine the direction breakers are moving?

Littoral Current (FOXTROT)

The littoral current must be measured and reported in each SUROB. The littoral current, also called the longshore current, is the current produced by the transport of the water caused by the breaking action of the waves. As the waves approach the shore at an angle, water is pushed up onto the beach at the same angle, and generates a net flow of water or a current. This current runs parallel to the beach and may be amplified by the presence of a longshore sandbar. Littoral currents are significant in that they can cause landing craft to drift off course and miss designated landing areas. Littoral currents are more common on straight beaches.

The velocity of a littoral current will normally be higher on beaches with steep slopes, and will increase with increasing breaker height and breaker angle. Velocities may reach speeds of 3 to 4 knots. Tidal currents parallel to the shore may intensify the littoral current or create opposing offshore currents. The speed and direction of the littoral current are reported in section FOXTROT of the SUROB.

MEASURING LITTORAL CURRENTS.—the measurement of speed and direction of the littoral current is fairly simple. Throw a piece of wood or other debris in the surf immediately in front of the inner most breaker, and pace off the distance in feet that it moves in 1 minute. The distance traveled by the debris in 1 minute divided by 100 is the speed of the littoral current in knots (10 feet of travel is equal to 0.1 knot). Several measurements should be made and the average reported to the nearest 0.1 knot. The direction of movement, or set of the littoral current, must also be reported as toward the left or right flank of the beach, as seen from seaward.

RIP CURRENTS.—Rip currents are formed when opposing offshore currents bend sections of a littoral current seaward, creating rip currents (popularly but erroneously called riptides). Rip currents are caused by water piling up along the shore. The water flows parallel to the shore for a short distance until it meets an opposing current or is deflected by bottom irregularities. Rip currents consist of three parts, the feeder current or currents which flow. parallel to the beach inside the breaker zone, the neck where the feeder current or currents converge and flow through the breakers in a narrow band or rip, and the head where the current widens and slackens outside the breaker line. Cusps (points) forming in the beach sand indicate rip currents are forming (fig. 4-7). An observer can usually distinguish a rip current as a stretch of unbroken water in the breaker zone where no breakers occur. The outer limit of the current in the head is usually marked by patches of foam and broken water similar to tide rips, and the head itself is usually discolored by suspended silt.

Although rip currents commonly exceed 0.5 knot (the sustained speed of a trained swimmer) and should be avoided by swimmers, rip currents frequently cut a deep channel perpendicular to the beach, which creates an area where the breaker heights are significantly lower than the prevailing surf. Rip current channels may, in rare cases, provide the easiest route through a surf zone for certain landing craft.

The presence of rip currents should be noted as a remark in element HOTEL of the SUROB report. In the rip current, the significant breaker height, ALFA, and maximum breaker height, BRAVO, should also be reported as a remark in element HOTEL. A position relative to the beach center may also be included. For example, the rip current may be reported as RIP CURRENT CHANNEL LEFT FLANK RED 30 YD WIDE ALFA 1 PT 5 BRAVO 2 PT 0.

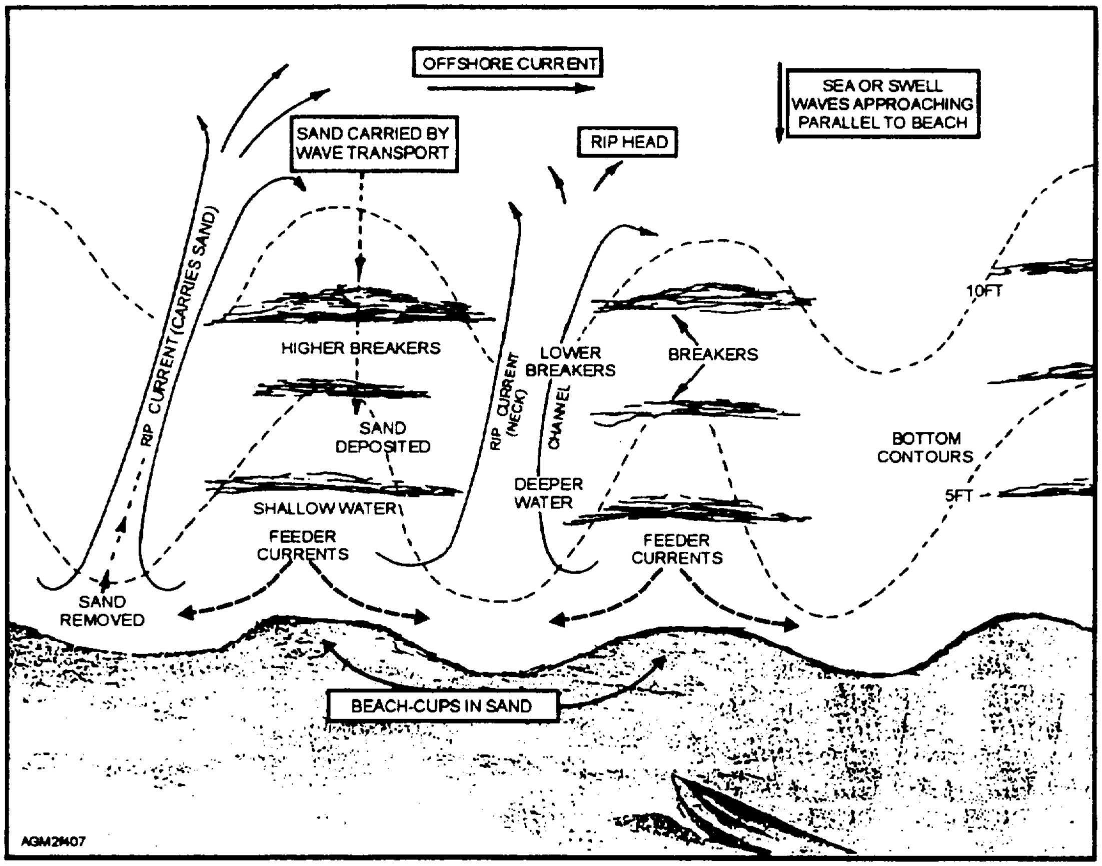

Figure 4-7.—Rip currents, beach cusps, and effect on breakers.

Surf Zone (GOLF)

As mentioned earlier, the surf zone is the area from the water uprush outward to the point at which waves first show any indication of breaking. The width of the surf zone is another element reported in a SUROB. This distance is often estimated by looking up or down the beach from a high observation point. You should compare the width of the surf zone to the known width of the beach area. You must also report the lines of breaking waves seen within the surf zone (perpendicular to the beach) at any given time. A shallow sloped beach tends to have several lines of breakers, in different stages of breaking, in a wide surf zone. A steeper beach tends to have fewer lines of breaking waves in a relatively narrow surf zone. The width of the surf zone and the number of lines of surf in the surf zone are reported as element GOLF.

Remarks (HOTEL)

Weather conditions, particularly wind data, are included as remarks in element HOTEL. In addition to the other remarks we have mentioned, brief comments about significant weather that may affect boat operations, such as low visibility or lightning, should be included. When weather personnel are assigned as SUROB observers, tactical surface weather observations may be taken in addition to the SUROB. This responsibility is normally assigned well in advance of an operation and will be described in the operation order.

When included, comments about the weather should be brief and in plain language; for example, HVY TSTRM WITH RAIN 10 NMI SE, CIG 030 BKN. or VSBY 7 NMI SEAWARD 2 NMI INLAND IN FOG.

WIND REPORTS.—Wind reports are mandatory. Winds should be reported as relative direction and speed. Estimate wind speed, and then determine wind direction, as shown in figure 4-8. Wind direction is always reported as the angle between the point from which the wind is blowing and a line normal to the beach. In addition, report the flank toward which the wind is blowing, and whether it is blowing from onshore or offshore. For example, winds would be reported as REL WIND 030° 15 KTS R FLANK ONSHORE or REL WIND 060° 08 KTS L FLANK OFFSHORE.

If true wind direction and speed measurements can be obtained, they should also be reported. For example, report TRUE WIND 320 AT 12 KT. The true wind direction and speed are used as inputs to modified surf index calculations by using the Tactical Environmental Support System (TESS) or the Mobile Oceanography Support System (MOSS).

Onshore winds are normally favorable to operations. Off-shore winds greater than 10 knots will tend to increase the surf zone, increase wave steepness, and produce a greater number of plunging breakers.

SECONDARY SURF.—Secondary surf is also a mandatory remark when applicable. When sea waves and swell waves or two sets of swell waves approach the beach from different directions, the breakers may occur in a large range of heights and periods, and the currents produced in the surf zone may be very erratic and dangerous. Information on the most significant set of breakers is reported in the main report. For example, report the larger breakers or report the breakers with the shorter period if both wave sets produce breakers of equal height. Complete information on the secondary set of breakers is reported following HOTEL with a remark, such as SECONDARY SURF ALPHA . . . BRAVO. . . and so on, including all parameters ALFA through ECHO. Elements FOXTROT and GOLF are not reported for secondary surf. The effects attributed to the secondary surf cannot be separated from the evaluation of surf zone and littoral current. The presence of deep-water waves and the resulting lines of breakers approaching the beach from different directions are the primary factor requiring secondary surf to be reported.

REVIEW QUESTIONS

Q16. How are littoral currents produced?

Q17. What may cause littoral currents to increase in velocity?

Q18. How can rip currents be identified in a surf zone?

Q19. What information is contained in element GOLF in a surf observation?

Q20. How should an onshore wind blowing at 045° at 12 knots, and blowing from left to right (as viewed from the beach) be reported in element HOTEL?

Q21. What are the effects of secondary wave trains moving into a surf zone?

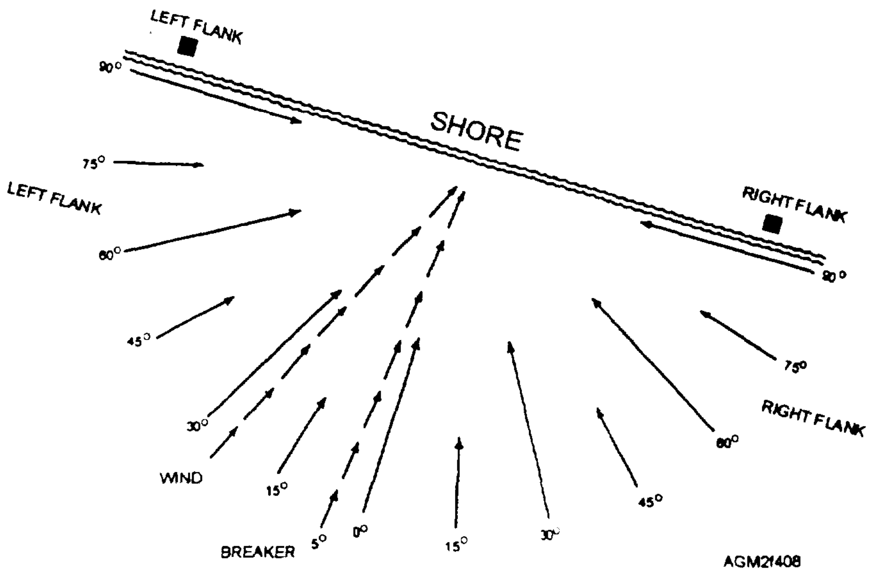

Figure 4-8.—Surf/wind angle diagram.

MODIFIED SURF INDEX CALCULATION

LEARNING OBJECTIVES: Describe the procedures used to calculate the Modified Surf Index (MSI). Identify features of the SURF program available in TESS/MOSS.

The modified surf index (MSI) is the most critical parameter in a waterborne assault. Both the SUROB observer and weather personnel aboard the task force command ship normally calculate the MSI from information contained in a SUROB. Additionally, surf forecasters at a center, facility, or detachment routinely calculate the modified surf index as part of the surf forecast.

The modified surf index is a calculated, single dimensionless number used as an objective decision aid. It is an assessment of the combined effects of breakers, littoral current, and wind conditions on landing craft. If the MSI exceeds the MSI limit for a particular craft, the landing is not feasible with that type of craft without increasing the casualty rate. The modified surf index is calculated on a locally reproduced Modified Surf Index Calculation Worksheet, shown as table 4-1. Tables 4-2 through 4-6 are used in computing table 4-1.

Table 4-1.—Modified Surf Index Calculation Worksheet

SUROB / SURFCAST NO. 5: VALID TIME: 2200Z - RED BEACH		
SURF REPORT ITEM	**MODIFICATION**	**ENTRY**
SIG BREAKER HT (ALFA) 4.5 FT	No modification, enter significant breaker height.	+4.5
BREAKER PERIOD (CHARLIE) 7 SEC	Enter value from breaker period modification table (table 4-2).	+1.6
BREAKER TYPE (DELTA) 70% SPILLING 30% PLUNGING 0% SURGING (see note below)	NO ENTRY FOR 100% PLUNGING SURF. Enter only a value for the percent spilling surf or the percent surging surf from the breaker type modification tables (table 4-3).	-2.8
BREAKER ANGLE (ECHO) 15 DEG	Enter modification value from the breaker angle modification table (table 4-4) as value (A)= 2.4.	Enter only greater value, (A) or (B) +2.7
LITTORAL CURRENT (FOXTROT) 0.9 KT	Enter modification value from the littoral current modification table (table 4-5) as value (B)= 2.7	
RELATIVE WIND (HOTEL) 15 kt at 35 DEG ONSHORE	Enter the value from the wind modification table (table 4-6).	+0.5
SECONDARY SIG BREAKER HT (HOTEL-ALFA) OFT	No modification, enter secondary significant breaker height.	0
(add all entries) - - - - MODIFIED SURF INDEX= 6.5		
NOTE: Surging breakers should occur on beaches with steep gradients and should not normally occur with spilling breakers.		

Table 4-2.—Breaker Period Modification

BREAKER PERIOD MODIFICATION

MODIFICATION ENTRY

PERIOD	.5	1	1.5	2	2.5	3	3.5	4	4.5	≥5
≥17	0	0	-.1	-.2	-.3	-.4	-.5	-.6	-.8	-1.0
16	0	0	-.1	-.1	-.2	-.2	-.3	-.4	-.5	-.7
15	0	0	0	-.1	-.1	-.1	-.2	-.2	-.3	-.3
14	0	0	0	0	0	0	0	0	0	0
13	0	0	0	+.1	+.1	+.1	+.2	+.2	+.3	+.3
12	0	0	+.1	+.1	+.2	+.2	+.3	+.4	+.5	+.7
11	0	0	+.1	+.2	+.3	+.4	+.5	+.6	+.8	+1.0
10	0	+.1	+.1	+.2	+.3	+.5	+.7	+.9	+1.1	+1.3
9	0	+.1	+.1	+.3	+.3	+.6	+.8	+1.1	+1.3	+1.7
≤8	0	+.1	+.2	+.3	+.5	+.7	+1.0	+1.3	+1.6	+2.0

SIGNIFICANT BREAKER HEIGHT (FT)

Table 4-3.—Breaker Type Modification

BREAKER TYPE MODIFICATION

MODIFICATION VALUE (A)

% SPILLING	.5	1	1.5	2	2.5	3	3.5	4	4.5	5
100	-.1	-.2	-.5	-.8	-1.3	-1.8	-2.5	-3.2	-4.1	-5.0
90	0	-.2	-.4	-.7	-1.1	-1.6	-2.2	-2.9	-3.6	-4.5
80	0	-.2	-.4	-.6	-1.0	-1.4	-2.0	-2.6	-3.2	-4.0
70	0	-.1	-.3	-.6	-.9	-1.3	-1.7	-2.2	-2.8	-3.5
60	0	-.1	-.3	-.5	-.8	-1.1	-1.5	-1.9	-2.4	-3.0
50	0	-.1	-.2	-.4	-.6	-.9	-1.2	-1.6	-2.0	-2.5
40	0	-.1	-.2	-.3	-.5	-.7	-1.0	-1.3	-1.6	-2.0
30	0	-.1	-.1	-.2	-.4	-.5	-.7	-1.0	-1.2	-1.5
20	0	0	-.1	-.2	-.3	-.4	-.5	-.6	-.8	-1.0
10	0	0	0	-.1	-.1	-.2	-.2	-.3	-.4	-.5

SIGNIFICANT BREAKER HEIGHT (FT)

MODIFICATION VALUE (B)

% SURGING	.5	1	1.5	2	2.5	3	3.5	4	4.5	5
100	+.1	.2	.5	.8	1.3	1.8	2.5	3.2	4.1	5.0
90	0	.2	.4	.8	1.2	1.7	2.3	3.0	3.8	4.7
80	0	.2	.4	.7	1.1	1.6	2.2	2.8	3.6	4.5
70	0	.2	.4	.6	1.0	1.5	2.0	2.7	3.4	4.2
60	0	.2	.3	.6	1.0	1.4	1.8	2.5	3.1	3.9
50	0	.1	.3	.6	.9	1.3	1.7	2.3	2.9	3.5
40	0	.1	.3	.5	.8	1.1	1.5	2.0	2.6	3.2
30	0	.1	.2	.4	.7	1.0	1.3	1.8	2.2	2.7
20	0	.1	.2	.4	.6	.8	1.1	1.4	1.8	2.2
10	0	.1	.1	.3	.4	.6	.7	1.0	1.3	1.6

SIGNFICANT BREAKER HEIGHT (FT)

Table 4-4.—Breaker Angle Modification

BREAKER ANGLE MODIFICATION											
		BREAKER ANGLE MODIFICATION VALUE									
A	40	+0.1	.3	.7	1.3	2.0	2.9	3.9	5.1	6.5	8.0
N	35	.1	.3	.6	1.1	1.8	2.5	3.4	4.5	5.7	7.0
G	30	.1	.2	.5	1.0	1.5	2.2	2.9	3.8	4.9	6.0
L	25	.1	.2	.5	.8	1.3	1.8	2.5	3.2	4.1	5.0
E	20	0	.2	.4	.6	1.0	1.4	2.0	2.6	3.2	4.0
	15	0	.1	.3	.5	.8	1.1	1.5	1.9	2.4	3.0
D	10	0	-1	.2	.3	.5	.7	1.0	1.3	1.6	2.0
E	5	0	0	.1	.2	.3	.4	.5	.6	.8	1.0
G											
		.5	1	1.5	2	2.5	3	3.5	4	4.5	25
		SIGNIFICANT BREAKER HEIGHT (FT)									

Table 4-5.—Littoral Current Modification

CURRENT (knots)	MODIFICATION	CURRENT (knots)	MODIFICATION
0.1	0.3	1.7	5.1
0.2	0.6	1.8	5.4
0.3	0.9	1.9	5.7
0.4	1.2	2.0	6.0
0.5	1.5	2.1	6.3
0.6	1.8	2.2	6.6
0.7	2.1	2.3	6.9
0.8	2.4	2.4	7.2
0.9	2.7	2.5	7.5
1.0	3.0	2.6	7.8
1.1	3.3	2.7	8.1
1.2	3.6	2.8	8.4
1.3	3.9	2.9	8.7
1.4	4.2	3.0	9.0
1.5	4.5		

Table 4-6.—Relative Wind Modification

RELATIVE WIND MODIFICATION								
		WIND MODIFICATION						
W	36-40KT	+2.0	3.0	4.0	1.5	2.0	4.0
I	31-35KT	1.5	2.0	3.0	1.0	1.5	3.0
N	26-30KT	1.0	1.5	2.0	0.5	1.0	2.0
D	21-25KT	0.5	1.0	1.5	0.0	0.5	1.5
	16-20KT	0.0	0.5	1.0	0.0	0.0	1.0
S	11-15KT	0.0	0.5	1.0	0.0	0.0	1.0
P	06-10KT	0.0	0.0	0.5	0.0	0.0	0.5
E	0-05KT	0.0	0.0	0.0	0.0	0.0	0.0
E		00-30°	30-60°	60-90°	00-30°	30-60°	60-90°
D		ONSHORE			OFFSHORE		
		WIND DIRECTION RELATIVE TO BEACH FACE					

The operation go/no-go decision is usually made by comparing the MSI (6.5 in the example) to the maximum, safe operating limits for each type of craft provided in the *Joint Surf Manual. The* SUROB observer should not be expected to make any recommendations, but may be expected to provide the modified surf index calculation. Recommendations will be made by the forecaster. The MSI can also be computed from the SURF program in TESS and MOSS by using input from the surf observation. In addition to MSI calculations, the SURF program produces a surf forecast based on forecasted sea/swell, wind, and tide information. Beach profiles can be created by manually entering distance versus depth information obtained from beach survey charts. This is usually accomplished by the observer.

REVIEW QUESTIONS

Q22. What is the purpose of the Modified Surf index?

Q23. When calculating the MSI what will be the value for a surf zone with 60% surging breakers and a significant breaker height of 3 feet?

Q24. When calculating the MSI, what will be the value for a surf zone with an offshore wind at 70° relative at 23 knots?

Q25. What program in TESS/MOSS can be used to compute MSI?

SUROB REPORTING

LEARNING OBJECTIVES: Explain when surf observations are reported. Explain the purpose of the SUROB Brevity Code.

Depending on conditions of the seas, tides, and winds, SUROBS may show significant changes every hour. No standard reporting times or reporting intervals have been established. The *Joint Surf Manual* recommends at least one SUROB every 12 hours, 2 to 3 days before an operation, and then increasing to hourly within 6 hours of the landing. Normally, operation planners will establish minimum reporting intervals and assign a time to commence observations and reports. The observer should routinely monitor the surf conditions and submit intermediate or supplemental reports whenever conditions change significantly. Nighttime surf observations are not nearly as reliable as daytime observations. Trends noted in the Modified Surf Index in combination with current meteorological parameters, such as wind and sea state, may provide the best estimate of actual surf conditions at night.

SUROB REPORTS

SUROBs are first passed to the Commander of the Amphibious Task Force (CATF), who normally remains on board the task force command and control ship. Reports are also forwarded to the command ship weather office and to the Naval Meteorology and Oceanography Command Center, facility, or detachment assigned forecast responsibility for the exercise or operation. These responsibilities are assigned in the weather support annex of the operation order.

SUROBs are normally passed via voice radio from the beach to the command ship. In a few situations, a copy of the SUROB worksheet may be passed directly to the CATF, or passed via light signal or flag semaphore. Before and during actual assault conditions, communications are heavily overloaded with critical command and control traffic and tactical traffic. Although the SUROB is equally as critical to the success of the operation, the message should be kept as brief as possible. In some cases, SUROBs are sometimes passed using the SUROB Brevity code.

SUROB BREVITY CODE

The SUROB Brevity code is a standardized method of encoding and transmitting surf observations by voice or flashing light when speed is essential. The Brevity code uses only letters to pass information. When passing these messages via voice radio, each letter is pronounced using the phonetic alphabet that you learned in the *Basic Military Requirements* (BMR) course. The message is passed as tactical traffic to the weather office aboard the command ship. Normally, the Brevity code is decoded by the weather office and forwarded to users in the task group in the standard SUROB report format. Only SUROB observers and personnel in the command ship weather office need to be familiar with the SUROB Brevity code.

The complete observation might appear as: WSKCC SUGGY ILELC JYBXC AW. The identifying features of the Brevity code are the first two letters, which are always WS, and the arrangement in a few groups of five letters. Complete instructions for encoding and decoding a message using the SUROB Brevity code are contained in COMNAVSURFLANTINST/COMNAVSURFPACINST 3840.1, *Joint Surf Manual.*

In the following text, we discuss the influence of tides on surf and some of the sources for obtaining tidal data.

REVIEW QUESTIONS

Q26. How can surf conditions be estimated at night?

Q27. Who are the primary users of SUROB information?

Q28. What is the purpose of the SUROB Brevity code?

TIDES

LEARNING OBJECTIVES: Recognize how tides influence surf. Identify the various methods for obtaining tidal data.

Tidal influences have little effect on the height of breakers but can have a profound effect on the width and character of the surf zone, the strength of rip currents, and sediment transport. As the water level rises and falls due to the daily change in tides, the water flow creates currents. These currents flow toward the shore as a *flood* current with the rising tide and away from the shore as an *ebb* current with a falling tide.

TIDAL EFFECTS IN THE SURF ZONE

During a tidal cycle, the position of the surf zone is shifted with the tide both vertically and horizontally, causing the intertidal beach profile to be slightly altered every 12 hours. In rip current systems, rips are strongest at low tide, when the water is sufficiently shallow to concentrate the flow of the current within the rip channels. Maximum rip current velocities occur during the falling tide, and on most beaches, rips become better developed when the tide is falling or low. Offshore bottom flow also increases during the falling tide. In addition, an increase in tidal range will result in an increase in sediment transport. This has a tendency to reduce beach gradients.

Normally, the surf zone will be wider at low tide than at high tide, given the same size waves. This is because the water level is lower and waves will begin to interact with the bottom farther from shore and break earlier. This wider surf zone can make the transit to the beach more difficult, and may cause equipment damage and troop fatigue. Also, sandbars and other obstacles, which have sufficient clearance at high tide, may be barely covered at low tide. This can cause landing craft to become hung up or beach prematurely. See figure 4-9.

TIDE CALCULATION

Semidiurnal tides consists of two low tides and two high tides in a 24-hour period in which each successive high and low water periods have nearly the same height. Diurnal (daily) tides consist of one low tide and one high tide in a 24-hour period. Mixed tides are semidiurnal tides in which each successive high and low water periods have different heights.

Tidal information is usually obtained from Quartermaster personnel, but is available from publications and prepared tables. A Tidal Prediction Program (TIDE) is available in TESS and MOSS using location-specific tide data. The TIDE program calculates hourly tidal information only for locations contained in the data base. However, adjustments can be made for substations using time and height corrections. Tidal currents are not predicted by the TIDE program. However, tidal currents can be estimated from tidal current tables produced by the National Imagery and Mapping Agency.

REVIEW QUESTIONS

Q29. A flood current is associated with what type of tide?

Q30. When are rip currents strongest?

Q31. Why is the surf zone normally wider at low tide?

Q32. Where can tidal information be obtained?

SUMMARY

Although you may rarely, if ever, be tasked to provide SUROBs, you must be familiar with the observation procedures and the terms used to describe surf conditions. In this chapter, we have explained the causes of surf and discussed nearshore hydrography and several key terms used in surf observations. We covered the actual surf observation (SUROB) and the calculation of the Modified Surf Index (MSI). We also discussed tides and their impact on surf.

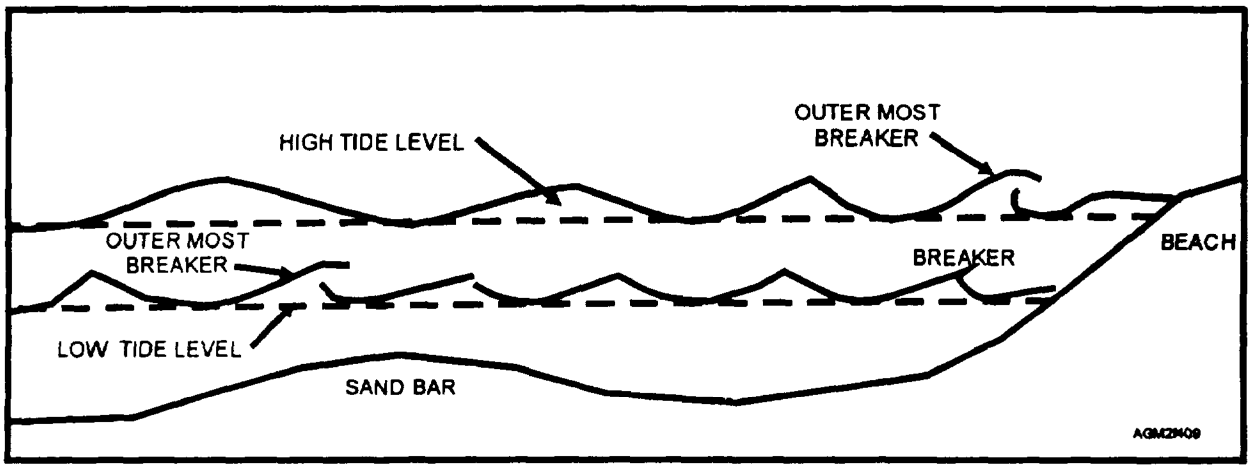

Figure 4-9.—Effects of tides on surf zone.

ANSWERS TO REVIEW QUESTIONS

A1. COMNAVSURFLANT/PACINST 3840.1 (Joint Surf Manual).

A2. Local onshore winds (creating sea waves) and swell waves traveling from distant fetch areas.

A3. The area between the shoreline and the outermost limit of the breakers

A4. Wave speed decreases, wavelength decreases, and wave height increases,

A5. The ratio of wave height to wavelength.

A6. Hydrography includes water depth, near-shore currents, tides, shoreline configuration, the beach slope, and bottom composition.

A7. Sandbars will cause waves to break farther from shore and with stronger force.

A8. Moderate.

A9. Sandbars may be exposed during low tide and cause landing craft to become hung-up on the bar.

A10. Wave refraction is the bending of waves toward areas of slower wave speed caused by interaction with the ocean bottom.

Al1. By color code or letter abbreviations.

A12. Significant breaker height is the average height of the highest one-third of the 100 waves observed, recorded to the nearest half-foot.

A13. Swell waves.

A14. Surging breakers.

A15. The direction of breakers is determined by the direction the breakers are moving <u>toward</u> as seen <u>from seaward</u>.

A16. Littoral currents are produced by waves approaching the shore at an angle, generating a net flow of water along the beach.

A17. An increase in breaker angle and/or breaker height.

A18. Rip currents may be identified as a stretch of unbroken water in the breaker zone where no breakers occur. The outer limit of the rip current is usually an area marked by patches of foam, and discolored by suspended silt.

A19. The width of the surf zone and the number of breaker lines

A20. REL WIND 045° 12 KTS L FLANK ONSHORE.

A21. Secondary wave systems create a more confused surf zone. with a large range of breaker heights and breaker periods, and littoral currents that may be erratic.

A22. The Modified Surf Index (MSI) provides an objective decision aid for amphibious planners that assesses the combined effects of breakers, littoral currents, and winds on landing craft.

A23. +1.4

A24. +1.5

A25. The SURF program.

A26. The most recent trends in the Modified Surf Index should be evaluated along with current meteorological parameters, such as wind and sea state.

A27. The Commander, Amphibious Task Force (CATF), the command ship weather office, and the Naval Meteorology and Oceanography Command assigned forecast responsibilities for the operation.

A28. To transmit SUROB information via voice or flashing light when speed is essential.

A29. A rising tide (high tide).

A30. A falling tide (low tide).

A31. The surf zone is normally wider at low tidesince the water level is lower and waves will begin to interact with the bottom farther from the shore.

A32. Tidal information can be obtainedfrom Quartermaster personnel, publications, prepared tables, charts, and the TIDE program in TESS/MOSS.